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Preliminary Review of the 63W10 Course at Aberdeen Proving Ground

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For this report, we observed training of 63W10 mechanics at the U.S. Army Ordnance Center and School and analyzed test scores for a sample of 16 classes. We also examined published data on performance deficiencies in U.S. Army Forces Command (FORSCOM) units. We found high failure rates for some tasks in the school and in the field. On the basis of our observations and analyses, we made 12 recommendations for improving wheel vehicle repairer training. One of them, improvement of classroom vugraph material, has already been implemented on the basis of a draft version of this report.

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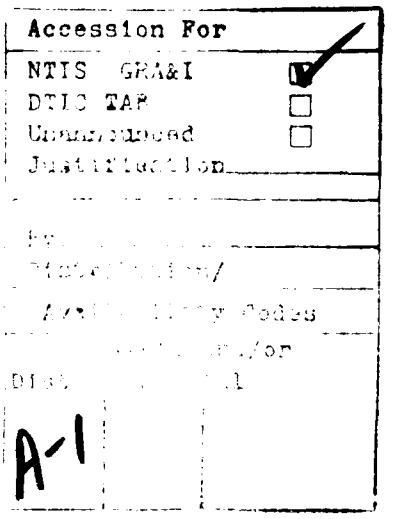
FOREWORD

The U.S. Army Research Institute (ARI), in cooperation with the U.S. Army Training and Doctrine Command (TRADOC) and its schools, performs research and development to achieve more cost-effective training. In a recent project, ARI joined with TRADOC and the U.S. Army Ordnance Center and School (USAOCS) to form a Training Technology Field Activity (TTFA) at Aberdeen Proving Ground, Maryland, to identify and solve maintenance training problems.

As a first step, ARI reviewed training practices in a selected course in the Wheel Vehicle Department at USAOCS. This effort was carried out by the Logistics Training Technologies Technical Area of the Training Research Laboratory. It is one of several near-term projects that will provide a basis for building a model program of instruction at Aberdeen Proving Ground.



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PRELIMINARY REVIEW OF THE 63W10 COURSE AT
ABERDEEN PROVING GROUND

EXECUTIVE SUMMARY

Requirement:

This report describes current practice for training wheel vehicle repairers and identifies opportunities for improvement.

Procedure:

We observed classroom activity in the 63W10 Wheel Vehicle Repairer Course at the U.S. Army Ordnance Center and School, Aberdeen, Maryland. In addition, we interviewed a cohort group of five students from a single class and administered questionnaires to them throughout the course. To supplement these data, we analyzed the results of end-of-block tests in Phases I and II of the course. Finally, we reviewed data on field performance obtained from a TRADOC performance evaluation.

Findings:

1. We found many opportunities to upgrade instructional materials and practices: classroom vugraphs were poor, evaluation of performance, especially hands-on, violated principles of good testing, panel training devices were not being used effectively, and some basic principles of instruction were not being followed.

2. Failure rates in some blocks of instruction reach high levels. The range of failure rates for the Electrical Annex was 15% to 75% across a sample of 16 classes.

3. Trainee interview and questionnaire data confirmed problems with instructional materials and suspected student fatigue. These data also showed that soldiers strongly prefer hands-on training. Phase I, almost half of the course, is largely lecture.

4. The TRADOC studies indicated serious skill deficiencies among 63W and 63B mechanics. Failure rates for five common tasks ranged from 85% to 99%.

5. We concluded the study by providing 12 recommendations for improving training.

Use of Findings:

The recommendations provided at the end of this report provide a basis for revising programs of instruction for Wheel Vehicle Repairers. One change has already been instituted as a result of our research. New vugraph materials are being developed as a result of draft versions of this report.

PRELIMINARY REVIEW OF THE 63W10 COURSE AT
ABERDEEN PROVING GROUND

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PRELIMINARY REVIEW OF THE 63W10 COURSE AT ABERDEEN PROVING GROUND

1.0 INTRODUCTION

1.1 Overview

This report is the first in a series which will document progress at the Training Technology Field Activity (TTFA), Aberdeen. In it, we summarize the preliminary results of a review of the 63W10 Wheel Vehicle Repairer Course. The report identifies some potential opportunities for improving instruction, but is not meant to be definitive or conclusive. It is part of a larger continuing effort to plan a long-range program of research, development, and implementation at the Ordnance School.

1.2 Background

a. The TTFA-Aberdeen resulted from a Memorandum of Understanding signed 15 May 1987 by TRADOC, USAOCS, and ARI. The TTFA goal is to improve the efficiency of maintenance training, the retention of skills, and the transfer of those skills to performance in units. It will do so by testing the usefulness of training research and promising new technology in a test-bed course and then helping to implement proven training methods and media at the Ordnance School.

b. An essential first step is to identify where documentable improvements to training can be made. We have started looking for clues to opportunities and will continue to do so through a variety of different activities. These include taking part as student-observers in the 63W10 course and examining performance data from the course and from operational units. The present report summarizes these activities to date and their results.

1.3 Methods

a. Course Observation. One member of the TTFA team (DR) sat through Phase I (Class 20) of the 63W10 course. He made notes on what was being taught, how it was being taught, and under what conditions. He also noted potential problems in training methods. A second member of the team (JK) observed instruction during Phase II of the course but did not follow a particular class.

b. Cohort Study. A third member of the TTFA team (RT) followed a group of five students in Class 20. He tried out a number of different survey instruments and questioning

techniques to try to identify portions of the course which could benefit from new technology. He met with the group on a regular basis throughout their training.

c. Review of Course and Unit Test Data. A fourth member of the team (AM) examined within-course test data and reviewed data from a field performance study conducted by the Training Analysis Command (TRAC). He summarized the test failure rates and the failure rates obtained by TRAC.

d. As a result of our observations and analyses, we discuss various proposals for course improvement on both a short-term and a long-term basis. A summary of these recommendations can be found in Section 7.0.

2.0 COURSE OBSERVATION (Phase I: BK&S)

2.1 Method of Observing

a. During the period 24 March to 6 May 1987 I (DR) attended classes for MOS 63W10, Wheel Vehicle Repairer given by the Wheel Vehicle Department, US Army Ordnance Center and School (USAOCS) at the Edgewood Area, Aberdeen Proving Ground, MD. The Program of Instruction (POI) covers a period of 15 weeks, 4 days for the 63W10 course but I covered only Phase I, a seven week period devoted to the Basic Knowledge and Skills (BK&S) portion. This part of the course is taught by contractor personnel (American Technical Institute). During this period, I observed the instruction given to Class 20-87, attending most classes with a few exceptions noted below.

b. Phase I is taught by Annexes with each Annex covering topics broadly associated with major automotive systems. At the conclusion of each Annex, a written, multiple-choice test is given ranging from 20 to 50 questions. Students failing to obtain a score of 70% are brought back, after school hours, given remdial training, and retested. At the conclusion of Phase I, an end-of-phase test is administered consisting of a 70-question written portion and a hands-on portion.

c. The following observations are organized by Annex and are followed by some general observations about the conduct of Phase I of the course. These comments are confined to observations about teaching and training conditions and not to content or whether the content matches the POI. Such a review can be found in an earlier report by the Department of Evaluation and Standardization (DOES) of the Ordnance School.

2.2 Results of Observations of Phase I of the 63W10 Course

a. Annex A: Common Subjects

Annex A covered the following topics:

A-1	Course Introduction, OPSEC, and Purpose of Soldier's Manual	2 hours
A-2	EEO and Sexual Harrassment	2 hours

A-3	Directed Energy Awareness	1 hours
A-3	Introduction of Physical Training (See Note below)	3 hours
A-4	Structure and Mission of US Army Maintenance Units	2 hours
A-5	Application and Use of TAMMS Forms & Records	2 hours
A-6	Use of Technical Publications	7 hours
A-7	Shop Safety/Maintenance Discipline	3 hours
A-8	Within-Course Test	2 hours

Note: This block was also listed as A-3 in the schedule.

b. Observations (Annex A):

(1) Class 20-87 contained 36 soldiers of which 17 were reservists (either Enlisted Reserve or National Guard). Most were E-1 or E-2 with one E-5, four E-4 and one E-3. There were two females.

(2) Classes began Tuesday, 24 March but I did not attend A-1 through A-3 since these sections did not pertain directly to course material.

(3) Classroom 126 contained tables and chairs to accomodate 40 students. Two TV monitors were mounted on raised platforms on either side of the front of the class. A large pulldown screen was used for Vugraphs. Platform lecture was the primary mode of instruction with one instructor covering sections A-4 through A-7. Short TV films were shown in sections A-4, A-6 and A-7. During section A-6, the students used several TMs and a fiche reader in a practical exercise.

(4) Classes were generally 50 minutes long with a ten minute break. Classroom discipline included promptness in returning from breaks, talking and 'keeping one's eyes open.' The latter problem was a recurrent theme throughout Phase I. Students were urged to move to the rear of the classroom and remain standing if they felt sleepy. As Class 20 moved through Phase I, a small group of students repeatedly used this feature, often to 'mess around' in the rear of the room. At this time of year, classroom temperature is crudely adjusted by opening and closing windows.

(5) Students were given a Supplemental Training Material Study Guide at the beginning of the Annex. This 110

page booklet covers in outline form much of the material contained in A-1 and A-4 through A-7. A written test of 30 multiple choice questions was given at the end of the Annex. One student failed to obtain 70% and required remedial training.

c. Annex B: Common Technical Basic Knowledge and Skills

Annex B covered the following topics:

B-1	Identification, Care, Purpose and Application of Hand and Power Tools and Common Hardware/ Fastening Devices	5 hours
B-2	Basic Operating and Design Principles of Mechanical Devices and Machines	9 hours
B-3	Basic Shop Math/Units of Measure and Introduction to Precision Measuring Tools	7 hours
B-4	Within-Course Test	2 hours

d. Observations (Annex B):

(1) I missed the first 3 hours of B-2 due to meetings as well as part of B-1 during which students inventoried the tool boxes issued earlier. Two hours were spent in a Practical Exercise (PE) on the use of the torque wrench, die cutter, straight edge, and the packing of gears with grease.

(2) Two TV films were shown on Planetary Gears and a large Mockup model used to supplement platform instructions. The films were old and of rather poor quality. As with other TV films shown, many students had trouble staying awake, a phenomenon noticed throughout Phase I with TV films.

(3) A short TV film was shown on the use of the micrometer after which students had in-class practice on the micrometer, vernier calipers and the metric micrometer. Several hours were spent on pencil and paper practical exercises in figuring areas and volumes.

(4) Annex B was taught by another instructor but was assisted during the PE on the shop floor by three others. Students were given a Supplemental Training Guide for this Annex. The written test for Annex B consisted of 20 multiple choice questions. Two students failed and required remedial training.

e. Annex C: Engine Systems

Annex C covered the following topics:

C-1	Construction and Operation of a Single Cylinder Gasoline Engine	3	hours
C-2	Repair Single Cylinder Gasoline Engine	15	hours
C-3	Construction and Operation of Multicylinder Engines	5	hours
C-4	Principles of Engine Cooling Systems	2	hours
C-5	Petroleum, Oil, and Lubricant Products	2	hours
C-6	Care, Use and Application of Bearings, Gaskets, and Seals	2	hours
C-7	Principles of Engine Lubrication System	3	hours
C-8	Disassembly of Diesel Engine	13	hours
C-9	Assembly and Adjustment of a Diesel Engine	14	hours
C-10	Within-Course Test	2	hours

f. Observations (Annex C):

(1) Classroom instruction and the single cylinder engine PE were held in classroom 123 which has student tables in the front and benches for the engines in the rear. Classroom 106 holds the diesel engines used in C-8 and C-9. Platform instruction for C-1 and C-2 was handled by another instructor who was assisted by two others during the disassembly and reassembly of the single cylinder engine. Since there were only 29 engines, some students had to double up on this PE. Supplements with detailed instructions were given to the students for the PE. The three instructors rotated through the class providing a fair amount of supervision during this PE.

(2) Because the single cylinder PE finished early, the students were given time on several panel simulators, one on Engine Starting (gasoline) and the other on Wiring and Lighting. Students worked in groups of 4-5 with 3-4 instructors monitoring activity. Rather skimpy instruction was provided on the operation of the simulators. This was, presumably, extra time and not listed in the POI.

(3) Platform instruction plus several TV films covered C-3 through C-7. Two aspects of the instruction deserve notice. Vugraphs projected on the screen at the front of the room were usually of poor quality and legibility, especially at the observer's table at the rear of the classroom. Often, they are

merely copies of TM illustrations turned into vugraphs. Parts of actual equipment are often used by the instructor by holding them up in front of the class and then passing them around the classroom while the instructor continues with something else. In this block, the instructor never wrote out words on the board and seemed to be reluctant to spell out terms the students seemed to have difficulty with. This instructor, as well as the two before him would routinely repeat (important?) terms or phrases several times to allow students time to write them down.

(4) Because of the length of Annex C, the within-course test was given at the end of C-8, before the lengthy PE involving the diesel engine. It contained 25 multiple choice questions and nine students scored below 70% requiring remedial training and retesting.

(5) The diesel engine PE was conducted using nine engines with students working in groups of four. They were provided with TM 9-2815-237-34 which is an excellent illustrated step-by-step guide to the disassembly of the 6.2 liter diesel engine. Three, and sometimes four, instructors were on the floor at all times. Since the class finished early, they spent some time on diesel panel simulators with minimal supervision.

g. Annex D: Fuel, Air, and Exhaust Systems

Annex D covered the following topics:

D-1	Fuels	2 hours
D-2	Principles of Gasoline Fuel Systems/ Components	5 hours
D-3	Introduction to Fuel Systems TMDE/ Fundamentals of Troubleshooting	3 hours
D-4	Repair of Gasoline Engine Fuel System	4 hours
D-5	Principles of Compression Ignition Engine Fuel Systems	6 hours
D-6	Repair/Test Compression Ignition Engine Fuel System	4 hours
D-7	Principles of Air Induction Systems	4 hours
D-8	Within-Course Test	2 hours

h. Observations (Annex D):

(1) D-1 through D-4 was taught by a new instructor, probably the best platform instructor up to this point. Classroom 124 required large standing fans to circulate air because of warmer weather. Although the classrooms are air-conditioned, it had not been turned on. The vugraphs in these blocks were of better quality than usual but again actual examples of equipment were passed around the class. D-4 was a PE on the shop floor using the STE/ICE test equipment on gasoline engines. There were six groups of six students with four instructors monitoring. Not all the students were actively participating. D-5 and D-6 was taught by another instructor. The practical exercise in D-6 on the shop floor was adequately covered by three instructors.

(2) The Annex D test consisted of 25 multiple choice questions. Six students failed and were given remedial training and retesting.

(3) Instruction continues to consist of platform instruction, TV films which are usually quite old, fair to poor vugraphs, and less than ideal classroom conditions. Students were not provided with illustrated supplemental material although several small outlines of blocks were provided.

i. Annex E: Introduction to Automotive Electricity

Annex E covered the following topics:

E-1	Automotive Batteries	3 hours
E-2	Principles of Automotive Electricity	8 hours
E-3	Introduction to Care and Maintenance of Electrical Test Equipment and Trouble-shooting Logic	9 hours
E-4	Within Course Test (NOT GIVEN)	
E-5	Vehicle Starting System	5 hours
E-6	Spark Ignition System	8 hours
E-7	Charging System	5 hours
E-8	Introduction to Soldering	4 hours
E-9	Troubleshooting Engine Systems	10 hours
E-10	Within-Course Test	2 hours

j. Observations (Annex E):

(1) The major problem with this annex involved moving the class to a small classroom right off the break area because of construction in the regular room. Several small fans were needed to circulate the air, and classes were cut short to provide more breaks. The front wall was used as a projection screen. These conditions continued for two days after which the class moved back to a regular classroom.

(2) Block E-3 involved PE with test equipment (a digital multimeter and STE/ICE) but students had to double up on the multimeter and work in groups of 5-6 on the STE/ICE. Instruction in this block was especially confusing and poorly conducted. Block E-5 contained one of the better TV films I've viewed to date. At the beginning of Annex E, students were given copies of TM 9-8000, Principles of Automotive Vehicles, on loan, to be returned at the end of the Annex. It is policy not to issue 9-8000, because of cost, but it is an excellent source book and some students complained about not being able to have a copy to keep. The quality of instruction during Blocks E-5 and E-6, with another instructor, was noticeably improved. The PE on troubleshooting the M880 engines was conducted with 5-6 students per engine and 3 instructors. Blocks E-7 and E-8 were taught by a new instructor who, although well organized and knowledgeable, had a pronounced accent. In room 125, which is quite wide, the screen for the projector was placed to the side of the platform causing distortion of the image.

(3) Block E-8, on soldering, was exceptionally well organized and detailed, although the PE required students to work sequentially through the several stations at the back of the room. Three instructors supervised the stations.

(4) Block E-9 on troubleshooting involved a short lecture period and then a PE on the panel simulators. Two instructors were available for students working in groups of four or five on two different types of simulators. Generally, the instructors dial in "problems" in sequence. As one instructor said, "There are no written instructions or 'tree' to follow." One student commented, "Those simulators don't teach us nothing." A major problem is that with groups of four or five. one or two students tend to take charge and the rest go along for the ride. There was less instructor supervision than in the other PEs, making it difficult to insure student participation.

(5) The Annex E test contained 50 multiple choice questions, the longest to date. Ten students failed and required remedial training and retesting. This was apparently successful since all students progressed to Annex F. I did not attend any of the remedial training sessions during Phase I.

Generally, they are held in the evening immediately or shortly after the within-course test.

k. Annex F: Brake Systems

Annex F covered the following topics:

F-1	Hydraulic Principles	1 hour
F-2	Hydraulic Lines and Fittings	4 hours
F-3	Fundamentals of Vehicle Brake Systems	5 hours
F-4	Within-Course Test	2 hours

l. Observations (Annex F):

(1) I missed most of Block F-2 because of a meeting on TTFA matters. The entire Annex was taught by one instructor using platform lectures with vugraphs. The latter were the most professional I've seen. They were clear, many in color and uncluttered. I missed the PE on flare tubing. The students were provided with a short supplemental study guide. The TV films were old but serviceable.

(2) The within-course test consisted of 20 multiple choice questions. Two students failed and required remedial training and retesting.

m. Annex G: Steering and Suspension Systems and Power Trains

Annex G covered the following topics:

G-1	Fundamentals of Steering Systems	4 hours
G-2	Fundamentals of Suspension Systems	3 hours
G-3	Fundamentals of Standard Transmission and Drive Line Power Units	4 hours
G-4	Fundamentals of Automatic Transmissions	4 hours
G-5	Disassemble Transmission	4 hours
G-6	Assemble Transmission	5 hours

G-7	Fundamentals of Drive Line Components	3 hours
G-8	Within-Course-Test (See note 2)	2 hours
G-9	End-of-Phase Test	5 hours

n. Observations (Annex G):

(1) Annex G, except for the transmission PE, is held in a classroom located directly off of the break area and the shop floor containing the gasoline engines. Warm weather required the two doors to remain open and large floor fans for ventilation. Two instructors covered the platform instruction. This classroom is the only one using a 35 mm slide projector instead of an overhead (Vugraph) projector. The slides were generally better than vugraphs used in other classes but not consistently so. Except for the temporary classroom used in Annex E, this is the worst of the Phase I classrooms.

(2) The within course test was given at the end of Block G-4 (because of practice for an Ordnance Day parade at the end of the week) instead of after G-7. The 25 item multiple choice test, however, contained no questions on Block G-7 anyway.

(3) Blocks G-5 and G-6, Disassembly and Assembly of Automatic Transmission, were conducted by a briefing in the classroom with outlines of steps to be taken, then on the shop floor. Students worked in groups of two or three on 15 units. Three instructors monitored progress with occasional help from a fourth.

(4) The End-of-Phase I test consisted of a 70 item multiple choice test and a hands-on section conducted on the shop floor. The latter required students to take four out of 8-10 tasks (somewhat randomly selected). Prior to the written portion, an instructor provided a review of Phase I, in the form of "hypothetical" questions. They were remarkably similar to the actual questions. With a passing grade of 70%, all but one of the students passed, one failing with 69%. Since the written and hands-on are averaged, all passed the Phase I exam.

2.3 Summary of Observations on 63W10 Course, Phase I

a. Overview

(1) In this section, I will summarize my observations

by broad categories. My approach to this course was to participate, for the most part, as a student with the exception of the practical exercises which I merely observed. I took all but one of the within-course tests and the written portion of the end-of-phase test. I attended all of the classes except for those missed because of meetings with TTFA members. I stayed with Class 20-87 during the entire 6 1/2 weeks.

(2) The 63W course uses a broad brush of training techniques and media including platform lecture, TV film, mock-ups, practical exercises, and work on panel simulators. More than half of the instruction, however, is by platform lecture (referred to as 'conference' in the POI). Many of the comments which follow are, of course, subjective.

(3) As an introduction to these observations, the following background information may be useful. Phase I of the 63W10 course, lasting approximately 6 1/2 weeks, is given in Building 5185 at the Edgewood Area of Aberdeen Proving Ground, MD. Instruction is given by civilian employees of a contractor with the exception of the first day when some military matters are covered by Drill Sergeants from the student battalion. Students are housed in the battalion area (about one mile from Bldg 5185) on Edgewood and are bused to and from Bldg. 5185. Classes are scheduled from 0630 to 1120 and 1250 to 1540 every day except Wednesday (usually) when classes end at 1020. Students are bussed back to the battalion area for lunch. They are under control of the battalion at all times except during training hours.

b. Specific Aspect of Training

(1) Instructors.

(a) Phase I was covered by 14 different classroom instructors augmented during practical exercises by several more. All are employed by the contractor, American Technical Institute (ATI), and meet the hiring criteria requiring subject matter expertise and prior military teaching experience. Most, but not all, were retired army careerists. For the most part, they were competent and firm though only three or four could be considered good platform speakers. Most instructors relied on repetition or placing embossograph cards on the board to emphasize points, rarely using the chalk board to present material.

(b) A major problem for each instructor was establishing discipline with respect to sleeping or nodding off in class. School policy is for a student to voluntarily get up and stand at the rear of the classroom if they feel sleepy. Instruction was often interrupted to admonish those caught nodding off. The policy itself was often subverted by the same handful of

students who would head for the rear of the class and horse around when the instructor wasn't looking. The daily schedule of the students, with reveille at 0430 and PT and GI parties after the school day, coupled with overly warm and un-airconditioned classrooms, made this a continuing problem throughout Phase I.

(2) Classrooms.

(a) Most of Phase I is given in a group of classrooms located in a separate section of Bldg. 5185 and protected to a degree from the noises of the shop floor and the large student break area in the middle of the building. They are similar in layout, with a platform area in front, and students sitting at small individual tables on padded chairs. Two 20/25 in. TV monitors are on elevated stands on either side of the front of the room. A large projection screen is either in the center of the front or off to one side. Lighting is quite adequate in all the classrooms. Three are inside rooms while the other two are on the outside with windows (opaque).

(b) The major problem, at this time of year, is ventilation and temperature control. Although the classroom area is equipped with airconditioning, it had not yet been turned on. After the first two or three weeks, when it turned warmer, this became a problem especially for the inside rooms. It was necessary to open the doors of these rooms to the hallway and turn on large, floor fans to provide circulation. Students were allowed to remove their shirts but the fans were fairly noisy and offered only a modicum of relief. The use of a temporary classroom in Annex E was particularly disruptive.

(3) Classroom Aids.

(a) Vugraphs (Overhead Projector for Transparencies) Throughout most of Phase I, the transparencies used were of very poor quality. Many appeared to have been made by Xeroxing illustrations or printed material from TMs. Although my eyesight and view from the observer's table at the rear of the classroom may have contributed to the problem, students appeared to have problems with them as well. There were some exceptions but, on the whole, they were quite unprofessional.

(b) TV Films. The TV films used throughout Phase I were quite old, although not necessarily out of date. Most were in black and white with a somewhat scratchy picture and tone quality. They were often introduced by a warning about staying awake. From the back of the room, the screens appeared quite small.

(c) Real Equipment. In a number of classes, the

instructor would hold up a piece of real equipment, for example, an alternator or injector nozzle, by way of illustration, and then have it passed around the class while he went on to something else. In a class of 36 it took some time for everyone to examine it.

(d) Mock-ups. Models, or mock-ups, were used in only a couple of classes, notably the sections on planetary gears, test meters and fuel systems (using a cut-away model of a diesel engine). The gear model needed some repair and the instructor had difficulty operating it.

(e) Chalk Board. Each classroom was equipped with a platform-wide chalk board but only three instructors routinely used it to illustrate material or to spell out terms. All instructors used the board to mount embossograph cards with topic or subject titles providing an outline of the lecture.

(f) Supplemental Handouts. In Annex A and B students were given book-sized (100 pages or more) study guides providing material on each of the blocks within the annex. The guides contained illustrations, outlines, and sample questions about the material. After that, supplemental material was sometimes provided in the form of topic outlines or in abbreviated form but never as comprehensive as the earlier ones. Detailed printed material was provided for the Practical Exercises (PE) on the single cylinder engine and the automatic transmission. During Annex E, students were given TM 9-8000, Principles of Automotive Vehicles, but had to return it at the end of the annex.

(4) Practical Exercises. There were three major PEs in Phase I; the single cylinder engine, the 6.2 L. diesel engine, and the automatic transmission. For the 36 students, there were 29 single cylinder engines, nine diesel engines, and 15 transmissions. There were at least three instructors on hand at all times to assist students during each of these exercises and to ensure that all the students actively participated. Detailed, step-by-step instructions were given the students but except for the single cylinder engine, not all students could perform all the steps required. In several of the other, shorter PEs where students worked in groups of four or five (especially the simulators) not all students actively participated. On the whole, considering the class size and equipment limitations, the PEs were well organized and conducted by the staff.

(5) Tests. The written within-course (end of Annex) tests were multiple choice ranging from 20 to 50 questions and covering material covered in classroom instruction. Instructors usually provided a review of salient points before each test. Having taken all but one of these test, and given the amount of

material covered in each annex, I would say they were generally fair and discriminating as witnessed by the number of failures and the need for remedial training and retesting. The End-of-Phase written test, on the other hand, appeared to be superficial and easy compared to the within course tests. On this 70-question multiple choice test one student failed with a score of 69%. During the hour before the test, an instructor providing a 'review' covered virtually most of the questions on the test. The hands-on portion required students to pass four out of eight or nine stations and the final score averaged the grades from the two parts.

3.0 PHASE II OBSERVATIONS

3.1 Method of Observing

a. Following Phase I, Annexes A-G, students begin Phase II with a one-week course in Basic Fundamentals of Recovery, Annex H. Annex H is taught by a separate division within the Wheel Vehicle Department at another location and will not be covered here. This section is a record of my (JK) observations of the remainder of Phase II of the 63W Wheel Vehicle Repairer Course at USAOC&S. Period of observation: 19 May to 26 June 1987.

b. Phase II is divided into annexes, I through M, usually having some correspondence to a particular vehicle subsystem, e.g., engine, brakes, transmission, etc. The Annex titles are as follows:

Annex I	Engine and Transmission
Annex J	Hydraulics and Electrical Interface Systems
Annex K	Brake and Suspension Systems
Annex L	Field Maintenance (FTX)
Annex M	Troubleshooting and Repair
Annex N	End-of-Course Comprehensive Test (EOCCT)

Each annex is divided into lessons, e.g., I-2, J-5, M-3, etc., most of which treat particular vehicles, e.g., M939, M977. Phase II lasts approximately seven weeks.

c. A typical lesson consists of a lecture portion, a hands-on portion, and a test (called a spot quiz). The lecture may include slides, slides with sound, videotape, vugraphs, pieces of actual equipment (AE) passed around, or demonstration on AE. The hands-on portion involves students performing a task on the AE, singly or in small groups, with close supervision/tutoring. Usage and adherence to technical manuals (TMs) is stressed. Spot quizzes are written multiple choice tests. Larger tests, called Within-Course Tests, are given at the end of an annex (J annex has also a midterm). These are usually written---not always. If a student passes, he moves on; if not, he is counseled/remediated until he does pass.

3.2 Results of Observations

a. I observed annexes I, J, K, L and M. The procedure described above proceeds smoothly in the "mature" annexes I, K, L and M. J annex is a bit different. It has been in existence

only about four months. J annex has its own building, E5778 which is about a mile from the main building. This building is not conducive to effective training: one electrical outlet, porta-potties, noise and more noise, a shared phone line, no heat/no air conditioning. These are known problems. The people at J annex have been reassured that something will be done. About half the training time in J annex is spent in the "motor pool", a parking lot several hundred feet away from the building. This presents a problem that is currently not addressed: in case of rain/snow the hands-on training must cease and there is no back-up plan (where to put students, what to teach).

b. At all the annexes observed, the connection between phases I and II is not obvious. If II is supposed to build on I, I didn't see any the linkage. The personnel concerned with the two phases are in separate organizations.

c. The finale to the 63W course is the End-of-Course Comprehensive Test or EOCCT. It is the determining factor in deciding whether a student graduates or is recycled. Eight hours is devoted to EOCCT. This period is allocated as follows:

(1) 4 hrs. to a major hands-on task (sometimes requiring two men) randomly selected from nine possible tasks,
(2) 2 hrs to TMDE (5 short hands-on tasks selected from a pool of 10)
(3) 2 hrs to a 50-item written multi-choice test

The testing time allocation/strategy derives from when the Wheel Vehicle Department had 24 hrs. in which to conduct EOCCT. (The 4 hrs. devoted to one task would seem to result in inadequate sampling of the subject matter, especially in light of the fact that two people must be given the same grade if they are assigned one of the two-man tasks.) Documentation of reliability or validity of this item or any of the EOCCT items was not available.

d. Test performance scores are confounded by a number of factors at the site. Every test, including and especially EOCCT is preceded by a review. The review targets virtually every test item. This happens just before the test is given. In the worst case (as far as insuring a high pass rate), a weekend intervenes between 'review' and 'test'.

e. It is clear that EOCCT governs what is stressed, however. Instructors make a point of telling students that they need to know something because it will be seen again on EOCCT. If EOCCT was a well-constructed test, this phenomenon could be a highly effective lever in assuring that important points are learned.

f. Reliance on manuals (TMs) is constantly taught. There are many, many manuals and they are exceptionally detailed (the SPAS concept). For most tasks, the major challenge is locating the pertinent information. Finding the applicable TM is taught in annex I. The next step, using the index and turning to the proper page, is reviewed in most lessons. All TMs are available in the students' barracks. (Note: Some highly experienced NCOs indicated that TMs are little-used in the field. Rather than refer to a bulky TM, it is common practice to ask a co-worker/supervisor how to do something.)

g. TMDE, Test-Measurement-and-Diagnostic Equipment, is an area of difficulty. Even though a TM may say to measure something, set-up of the TMDE and understanding readings present a problem. (EOCCT data should show this.) This was witnessed for all TMDE.

h. During my observation period, failure on the "injector pump" (4 hrs, hands-on, EOCCT) caused three students to be recycled for a week. While the random assignment to one of nine major hands-on tasks permits an assessment of training, it is obviously an unfair draw for a student. The major hands-on tasks of EOCCT are not of equal difficulty.

i. At the same time as I was conducting my observations, the Wheel Vehicle Department was trying out team teaching in Phase II. Instead of students encountering a different group of instructors at each annex, one group of 6-8 instructors is linked to a class and teaches all annexes. Some pros of team teaching are, 1) variety and development of instructors; 2) increased instructor knowledge of students' strengths/weaknesses; 3) concern for and pride in student accomplishment; and 4) better management of student group composition/activity to insure each student performs important hands-on tasks. Some cons of team teaching are, 1) reduced depth of expertise provided by specialists in each annex; 2) reduced concern for training equipment; 3) reduced maintenance of training equipment; and 4) reduced standardization of lesson presentation. I suggested that a compromise might be to have one or two class advisors follow a class through the course. Instructors would take on this role every year or two. I believe that this would be more cost-effective than having 6-8 instructors attached to a class since this many are rarely needed to present a lesson. Normally, instructors are locked into one annex. An adviser assignment would serve to cross train them and add variety to their jobs.

j. The strength of Phase II is clearly in the hands-on training on actual equipment. Students like it. They are awake and alert when doing it. (The contrast between lecture and hands-on in this matter is vivid.) There is a psychomotor kinesthetic feel for tools and machinery that is obtained by the students which cannot be obtained in any other way. The

hands-on sessions are virtually tutorial, i.e., low student/instructor ratios, readily-available instructors, instructors who are experts, and detailed instructions in the form of TMs. Within its respective scope, each hands-on part of a lesson is necessarily relevant, valid, and effective. A worthwhile TTFA goal is to find ways to accomplish more hands-on training within the time and resources currently available.

4.0 STUDENT COHORT OBSERVATIONS

4.1 Method of Study

a. Five soldiers were selected from about 25 volunteers in Class #20. An attempt was made to select a small group with a diverse background based on information gained from ASVAB scores, comments from their Drill Sergeant, and an informal questionnaire.

b. Information was gathered from the group by means of questionnaires which were handed out on a weekly basis. Essentially, the students were to rate lessons in terms of quality of each lesson. Informally, I (RT) met with the participants each week to confirm questionnaire responses and to obtain greater detail when instructional problems arose.

c. The format of the questionnaire was changed several times over the course of the project in order to get more detailed information about specific lessons. However, the small number of respondents precluded any meaningful statistical analyses of the data. The questionnaires and group meetings did provide insights into student reactions to the instruction and corroboration of observations made by the other observers.

4.2 Preliminary Results and Conclusions

The following conclusions are based on the verbal and written comments of the five soldiers and the questionnaire responses.

a. Although all the cohort members passed the various within-course tests, there were large differences in terms of their interest and confidence in knowing course content. There were also differences in their perception about the importance of scoring high on the end-of-annex tests. The two highest scoring soldiers believed that high scores increased their chances of getting 63W job assignments at their first duty station. The other three were concerned mainly with making the minimum required score. As they gained experience in the course, all soldiers learned how to succeed. That is, they learned to memorize points that were explicitly highlighted by instructors because these points (almost) invariably appeared later on as test questions.

b. Throughout Phase I and Phase II, the group members noted marked variation in the quality of instruction. One instructor in Phase I and another in Phase II were singled out by all five

as outstanding instructors while two or three others were singled out as particularly ineffective. In filling out the Phase I and II questionnaires, the group members were most consistent in their evaluation of instructors.

c. Although there were some differences of opinion, the cohort members desired more hands-on experience because it motivated learning. One soldier criticized early hands-on PE's because instructors did not allow enough time to make notes. Later on, she realized that taking notes was not necessary to pass end-of-annex tests.

d. Technical Manuals. TM's were frequently criticized. The main problem, in Phase I, occurred because soldiers did not own key manuals, particularly TM 9-8000. It was handed out for three or four weeks and then taken back because the training department did not have enough to go around. One soldier demonstrated the problem by comparing his notes, with and without TM 9-8000. Having the manual greatly enhanced the organization and detail of his notes. In Phase II, which is heavily hands-on, soldiers complained about missing or smudged pages that made it impossible to follow prescribed repair steps. There were also a number of comments that the description in the manual did not seem to match the problems presented by the vehicle.

e. In Phase II, comments and questionnaire responses indicated substantial amounts of student inactivity. Apparent reasons included equipment constraints that limited the number of work stations and wait times necessary for slower soldiers to catch up. Soldiers also noted that Class #20 suffered because it was used to test the new team-teaching concept. Delays resulted when the instructor team had to learn or relearn procedures at the same time as the 63W10 soldiers.

5.0 RESULTS OF TEST DATA REVIEW

5.1 Treatment of the End of Annex Test Data.

a. Method and Results. Phase I of the 63W10 Course is divided into 7 annexes of instruction. Students are given written tests at the end of each annex. The TTFA at Ft Knox found these tests to be useful in identifying problems to be solved by TTFA projects. Consequently, we undertook to compile summary test data for the 63 Whiskeys. For 10 completed and 5 partially completed classes, we tallied the number of test failures (i.e. requiring remediation) by annex and class and then computed the average failure rates per annex. Course size varied from 25 to 53 students. Summary data are presented in Table 1. Detailed class data are presented in the Appendix.

TABLE 1

Performance Failure Data for 63W10s

Annex	Failures	Average Rate(%)	Min-Max Rates(%)
A. Common Subjects	(40/560)	7.14	0.00-27.78
B. Basic Skills	(30/557)	5.38	0.00-34.62
C. Engine Systems	(166/530)	31.32	9.09-76.00
D. Fuel, Air, Exhaust Systems	(35/416)	8.41	0.00-22.50
E. Intro to Auto Electricity	(64/410)	15.60	2.94-36.36
F. Brake Systems	(20/367)	5.44	0.00-27.27
G. Steering and Suspension	(10/368)	2.71	0.00-13.79
[Note: All classes had completed Annexes A through C when these data were compiled]			

The data in Table 1 indicate that Annexes C and E experienced the highest average failure rates at 31 and 15% respectively. But variations in these rates are notably large for all the

annexes, as shown by the Min-Max column. And, the relatively low averages for annexes other than C and E obscure the fact that many classes in those annexes experienced very high failure rates (See Appendix).

b. Discussion and Conclusions. Failure rates are most severe for the first experience with automotive systems (Annex C) and for the block of instruction on automotive electrical systems. It is also noteworthy however, that the variations are large. This suggests that individual differences may play a substantial role in the outcome of instruction and that perhaps a follow-up analysis of student characteristics might uncover some useful clues about alternative approaches to training. In any case, the data suggest that it may be productive to focus on Annexes C and E in future TTFA planning.

5.2 Treatment of Test Data - Phase II

a. Method and Results. Within-course test data were obtained for eight recent classes (9-87 through 16-87) in Phase II covering Annexes I through N (EOCCT). These data covered both performance and written (multiple choice) tests. The failure rates were generally very low with the exception of the within-course written test given halfway through Annex J (J-6) and the written portion of the EOCCT (N-1). These data are presented in Table 2.

TABLE 2

Performance Failure Data for 63W10s - Phase II

Test	Failures	Ave.(%)	Range(min-max)
J-6 (Hydraulics & Elect.)	46/257	17.89	6.66-30.00
N-1 (End-of-Course Written)	55/257	21.40	6.66-50.00

b. Discussion and Conclusions. Significant failure rates occurred in both of these written tests. The test results in Annex J may reflect the training conditions mentioned earlier, or a continuing problem with more abstract subjects such as hydraulics and electricity, or both. It should be noted that the written portion of EOCCT is averaged in with the other two parts to arrive at a final grade.

5.3 Treatment of TRAC Field Performance Data

a. Method and Results. The TRADOC Analysis Command (TRAC) conducted a training effectiveness analysis at five sites: Ft. Knox, Ft. Stewart, Ft. Hood, Korea, and Hawaii. As part of its effort, TRAC measured hands-on performance for five tasks. The results (drawn from an "Emerging Results Brief", dtd 5 Jan 1987) are summarized in Table 3.

TABLE 3

Performance Failure Data for 63Ws and 63Bs

MOS	Task	Failures	Rates(%)
63B	Prepare Maintenance Worksheets	102/103	99.03
	Test Starter Circuit	92/95	96.84
	Replace Brake Pads	91/98	92.86
63W	Prepare Maintenance Worksheets	103/106	97.17
	Replace Steering Gear Assembly	89/104	85.58

b. Discussion and Conclusions. The data indicate substantial and consistent failure to perform tasks in the field, tasks which are part of the critical list for 63 MOS mechanics. But the significance of the failures, particularly for training strategy at the school house, is not necessarily obvious. Whether the poor performance is the result of forgetting, inability to transfer skills to equipment not previously experienced, or job-test conditions which do not normally exist in operational units is not discernable from the data. In any case, floor effects are in evidence and the reason(s) for this should be determined in any further tests of field performance.

6.0 EMERGING CONCLUSIONS ABOUT TRAINING TECHNOLOGY FIELD ACTIVITY ACTIVITIES

6.1 Environment for Introducing New Methods and Technology

a. A number of ideas are emerging for opportunities to improve training in the 63W10 course which will be discussed below. First, however, we want to summarize some observations about the current training environment, especially about those aspects which may constrain or otherwise influence the introduction of new training technology. If TTFA is to be successful, these aspects should be considered in its planning.

(1) Soldierization, the term given to the soldier's day outside of the school house under Battalion control, often conflicts with training at the AIT school. Any change in the school curriculum or training approaches must contend with early morning starts and long days.

(2) Student performance evaluation is based primarily on written tests even though most of the instruction in Phase II, and some in Phase I, is based upon practical exercises.

(3) Minimization of failures or dropouts from the course is assured through questionable remedial training and retesting.

(4) There is a separation of the teaching of theory and principles (Phase I) from practical application (Phase II).

(5) Although the MOU establishing the TTFA-Aberdeen permits "experimental" changes in the POI, the current program is the result of a complex interaction between the Wheel Vehicle Department, the Directorate of Training and Doctrine and the Department of Evaluation and Standardization, all operating under TRADOC policy. These "interested parties" are a community of training and evaluation specialists and subject matter experts concerned with the quality of technical training.

b. The soldierization regimen sets the underlying tone for technical training by turning the training day into something like a forced march. In the classroom, student performance is undermined by tiredness, regimentation, and lack of instructional incentives to excel. In addition, the training department as well as the trainees are constrained by limited resources (i.e., too few copies of manuals to let each soldier own one), by a POI heavily weighted toward memorization, and by

poor classroom environments.

c. The most positive aspect, where trainees and staff are most productively engaged, is the hands-on training. However, the separation between the teaching of theory and principle (Phase I) and application in hands-on experience (Phase II) mitigates against integration of theory and practice.

d. Where the success of instructors and students alike depends on passing tests, "teaching to the test" is inevitable. Where tests are valid, reliable, and relevant, this phenomenon can be turned to a positive result. The Wheel Vehicle Department's testing practices need considerable development.

6.2 Short Term - Phase I

a. Phase I of the 63W10 course, the Basic Knowledge and Skills portion, lasts about 6 1/2 weeks and consists primarily of traditional platform lecture and several long practical exercises. The aim of Phase I is to introduce the student to basic automotive principles as embodied in the major systems of wheeled vehicles. The suggestions for improvement that follow are based on personal observations made while following one class throughout Phase I.

b. As a short-term project, the TTFA should address correctable deficiencies in presentation methods and media rather than course content. The following suggestions would not change the POI or the scheduling of classes in any way and would not require any large expenditure of funds. Furthermore, the effort could be conducted as a pilot research project of modest scope and expanded if the results are promising.

c. There are several problem areas in Phase I which might be addressed by TTFA as research efforts on an immediate and short-term basis.

(1) Visual Aids.

(a) Most visual aids in the course are in the form of transparencies (Vugraphs), shown on an overhead projector. With a few exceptions, the quality of these graphs is uniformly poor. Many appear to have constructed by making transparencies from Xeroxed illustrations taken from TMs or other such sources. They are often blurry, too "busy" with unreadable or hard to read text, or too complicated for short-term viewing by the class. The projection screen is not always centrally located at the front of the room, sometimes causing distortion of the image. Given the nature of the material being presented, i.e., engineering principles embodied in mechanical devices, clear illustrations are of obvious importance.

(b) A small pilot experiment could be conducted by selecting a lesson or group of lessons within an Annex containing poor visual aids. These materials would then be redesigned and redrawn by professional artists. The lessons chosen would have to cover material substantially included in the normal within-course (end-of-annex) tests in order to have criterion measures. As part of this experiment, we might provide a better projection system for the classroom in which the selected lessons are given.

(2) Television Films.

(a) The TV films used throughout Phase I are a mixed bag. Most of them are quite old and although the content is still valid the impact is lessened for kids who grew up with TV by the style and presentation method. Some of the films look like old 8- or 16-mm training films transferred to TV tape. That they may be less than effective is evidenced by warnings about falling asleep given before each film.

(b) Short of making new films, TTFA might look into the availability of better and more recent material. Additionally, we might look into replacing the two TV monitors at each side of the front of the class with a single, large-screen system.

(3) Supplemental/Study Guide Materials.

(a) At the beginning of Annex A and B, students were given book-sized study guides. These guides contained numerous illustrations, outlines, and sample test questions covering the material presented in the classroom. In none of the following annexes were the students given a single, comprehensive study guide. Sometimes, students were given study outlines, appropriate for classroom notetaking, and materials for the practical exercises. TM 9-8000, an excellent basic text on automotive principles, was loaned to the students during Annex E, but was not issued. Some students complained about not being issued the TM so they could study at night. Essentially, the students are without a basic textbook and must rely heavily on the notes they take in class.

(b) Several possibilities exist for TTFA intervention in this area. We could underwrite the cost of producing additional supplemental study guides such as the ones used in Annex A and B, or the cost of issuing TM 9-8000 to each student towards the beginning of the phase.

(4) Actual Equipment. Equipment components are sometimes passed out at the front of the class to be passed back to the students. This practice is actually counterproductive since the instructor then goes on to other material while the

sample is being examined. If AE examples are to be used, then enough should be available (one per every 2-3 students) and passed out beforehand so instruction can be geared to the example.

(5) Practical Exercises. The three major PEs in Phase I, the single cylinder engine, the 6.2 L diesel engine, and the automatic transmission, are well organized individual or group activities. Several of the other PEs suffer from a lack of equipment which could be easily remedied, although the effects may not be easily measured.

(6) Instructors. Instructors in Phase I, although employed by a contractor (ATI), are required to take the three-week Instructor Training Course given by the Staff and Faculty Branch at APG. The TTFA might try to obtain more information about this course because a number of the instructors I observed seemed decidedly deficient in basic teaching techniques.

d. The general impression I (DR) got from 6 and 1/2 weeks of instruction in Phase I was that learning was a struggle. The lecture/classroom situation was often less than adequate as a training environment. The students had to cope with a training day that was overly long (9+ hours with almost 8 hours in the classroom) made longer by the regimentation of battalion life and its "soldierization." The TTFA might start by trying to improve, in some small ways, the classroom environment.

6.3 Short Term - Phase II

In the next paragraphs are some recommendations for improvements for the 63W course. Some are narrow and specific, others are more global. All are based on my (JK) observations of Phase II.

a. Testing.

Testing, including and especially EOCCT, is the weakest area in the course. Improvement is needed in all parts of this area, but the most critical is EOCCT because it is the tail that wags the dog. A clear target for revision is the written test portion of EOCCT. (Incredibly, it is shorter than the written portion of the Phase I test. Surely there is a lot more material to be covered!) It is recommended that an effort be launched which produces the following:

(1) item pools
(2) item statistics

(3) alternate forms
(4) test statistics
(5) better materials
(6) feedback to students

Another EOCCT part which drastically needs changing is the four-hour hands-on task. The time spent is much too long to justify inclusion. The assignment of a student to one of nine possible tasks results in unfairness because the tasks are not of equal difficulty. It is recommended that a hands-on test battery be developed which efficiently samples the critical aspects of tasks and that all students do all of them.

It is recommended that the TMDE part of EOCCT require all students to do all stations. To provide time to do this, it is recommended that some time limits be developed for the TMDE tasks. For example, the time needed for 95% of the students to finish might be determined over several classes and used as a limit.

b. Utilization of available equipment

In Phase II there is an enormous amount of actual equipment. On the shop floor there are approximately 50 vehicles and there are another 10-15 at the outdoor sites. On the average at any one time, half of these are not in use. It is recommended that a way be found to schedule more student time on the available equipment. (It also can be noted that for a lesson on a particular part of vehicle, a whole vehicle is used. This seems like a waste of the rest of the vehicle.) Another note, which might help someone trying to improve scheduling, is that lessons are exceedingly modular, i.e., it makes no difference what order lessons are presented in Phase II since they do not build on each other.

c. Training aids

Phase II is primarily conducted on actual equipment using technical manuals. Each lesson, however, is preceded by an introductory lecture/conference. Vugraphs made by instructors from TM illustrations are a staple of most of these introductory sessions. Production quality is uniformly poor. It is recommended that professional graphics people be hired/tasked to construct all vugraphs. A good place to start is lesson I-1, Publication Use and Application, for which no vugraphs exist. Pertinent pages of DA Pam 310-1 (a microfiche) could be made into instructive vugraphs.

More elaborate training aids might more effectively explain certain dynamic processes. For example, the concept of timing a diesel engine could be rendered quite concrete through

computerized graphics. Similarly, the workings of a hydraulic system could be made transparent, vivid, and in apprehensible time sequence.

Another area where the concretization of concepts is needed is TMDE (Test, Measurement, and Diagnostic Equipment). (This point may be more appropriate to Phase I, but the difficulties were observed in Phase II.) Prominent trouble spots are the micrometer and the multimeter. In the case of the micrometer, the problem seems to be deciphering the readings. Large-scale replicas or video blow-ups of micrometers would make effective teaching tools. The digital multimeter is a fine instrument, but it is overkill for 63W and auto mechanics generally. However, since it is in the Army inventory, ways need to be found to properly use it. For the few measurements a 63W might make, it is suggested that a job aid/training aid be developed showing exactly what buttons to push, what connections to make, and good/bad determination.

d. Instructor offices

Phase II instructors have desks in a dimly lighted barn-like room. Significant upgrades are sorely needed, at least to the level of the Phase I contractor offices.

e. Student motivation

Certain tasks have a natural built-in motivation, e.g., the machine now works or works correctly whereas it didn't before. For the most part, Phase II is very good about insuring some form of demonstrable payoff to the students for their efforts on a particular lesson. In a few cases, however, the constraints of the school situation do not permit a satisfying task conclusion to emerge. Lessons on the installation of a transmission, the evaluation of brake rotors, the tracing of a schematic diagram are examples of tasks which stop short of seeing some achievement. It is suggested here that student motivation may need a boost under these circumstances when they are identified, i.e., instructors recognize and reward achievement of intermediate criteria.

Besides just getting a task done, there is the matter of getting it done in good time. While it might be wise not to hurry these novices who are usually making their first attempt at a task, it might be a motivating factor to show them the manner and pace of a master. This could be a video of how one or two of the training tasks is accomplished in the field/maintenance shop. This would give students an idea of the appropriate standard to strive for as well as a transitional glimpse.

g. Miscellaneous

(1) We were not able to obtain an audit trail of how tasks have been selected for school training. The 1985 Soldiers Manual is out of date and inadequate for TTFA purposes.

(2) Equipment that the students work on is nice and clean. This is good and necessary, but it would be valuable to teach a few things about the real-life conditions like rusted nuts, stripped bolts, fluid spills, etc.

(3) Also, while a considerable emphasis is placed on safety/accident prevention, there doesn't seem to be any attention paid to what to do in case something happens, e.g., a fire or a serious injury.

(4) PS Magazine is an informative publication, often the first to put out the word about many things. Recommend that all students be provided the latest copy.

h. Overview of Phase II

If the tasks included in Phase II are critical job tasks, then the training provided is very effective. Students are virtually tutored on what to do and how to do it, and they use actual equipment. Although the technical manuals are sometimes maligned for their bulkiness and information locating problems, the clarity of presentation is excellent. In the absence of time pressure, which is the situation in the school, correct task performance is nearly always achieved. ("Correct" is not expert, however; an expert is also fast.) The challenge for TTFA is to pack more into the training both in terms of individual practice and breadth of experience.

6.4 Long Term

a. Use of Training Devices.

(1) The issue of use of training devices has both a short-term and a long-term aspect. Use of devices, particularly panel trainers appears to be less than optimal at Aberdeen, either because students don't know how to use them, down-time is severe, or too many students crowd around a device and may not get equal access to its capabilities. i.e. some students may "go along for the ride."

(2) In the short-run we might consider developing training materials and/or job aids to help students learn how to use the devices. The longer-range and tougher problem is the high "student to device ratio". This problem was alluded to in

the recent report by Kessler, MacPherson, and Mirabella (1987) and goes back to incomplete concept formulation before the device is acquired. The authors pointed out that concept formulations - at least in the past - have not paid serious attention to whether or not the device - as configured and designed - could be used efficiently, given the student load and flow.

(3) Implication: Study and document the device use problem with a view towards updating ARI's Device Acquisition Guidelines (Kessler, Macpherson, and Mirabella, 1987), and making specific recommendations for the 63W10 course.

b. Problems with abstract subjects - e.g. hydraulics and electricity.

(1) A variety of sources of data and observation indicate that trainees have problems with some of the more abstract aspects of automotive systems, e.g., electricity. Research on metaphors and mental models suggests some useful techniques for addressing this problem (Royer, 1979; Kieras and Bovair, 1984; Gentner and Gentner, 1983; Halff, Holland, and Hutchins, 1986). Use of these techniques can significantly improve a trainee's ability to learn and remember procedures as well as abstract material, but only if the techniques are designed with certain principles in mind. These principles are stated in another TTFA report (Mirabella, Macpherson, and Patterson, 1988). The general answer to this problem is to integrate maintenance theory and practice by combining Phases I and II and teaching only as much theory as is needed to support hands-on training. To do this properly, USAOCS would have to adopt a much more performance-oriented approach to training design, an approach where USAOCS first defines the skills it wants to train and then selects and incorporates only the most relevant theory.

(2) This can be part of a larger question: Assuming that BK&S, properly designed, can help students retain and generalize maintenance skills - how can it be most effectively designed? Use of metaphors could be part of the answer. Better mixtures of lecture and "hands on" exercises may be another part of the answer.

(3) We are getting some indications that BK&S may not be well connected with Phase II, and that perhaps there are some things we could do improve the Phase I - Phase II linkage. The problem is two-fold: Getting students to remember what they learned in Phase I and to use those principles to learn Phase II tasks more effectively.

c. Maintenance Skill Decay. Skill decay is a very severe effect (Shields, Goldberg, and Dressel, 1979) especially for the most critical tasks (Mirabella, Macpherson, and Patterson, 1988).

Years of research on skill retention, including some very conclusive recent, applied research at APG itself, suggests that there are a number of ways to reduce the effects of forgetting. We recommend that a major effort be undertaken to introduce skill decay "prevention" techniques, including better use of job aiding. This problem is discussed in detail with specific recommendations in the follow-up report by Mirabella et al. (1988).

7.0 RECOMMENDATIONS

7.1 Summary

The 63W10 course graduates approximately 1500 soldiers each year. The active component soldiers are sent to apprentice-level positions in DS/GS maintenance units worldwide where they receive further training and experience with the Army's entire range of wheeled vehicles. The foregoing needs analysis has shown how extensive the training program is and has suggested various areas where improvements might be made. In conclusion, we offer the following summary of our recommendations for course improvement.

Recommendations

a. Develop a methodology for integrating Phases I and II.

b. Improve the visual aids that support lectures using the TTFA-developed guidebook on visual aids.

c. Provide Study Guides for all annexes and copies of TM 9-8000 for students to keep.

d. If actual equipment (AE) examples are to be used during lectures, then provide one unit of AE per 2-3 students and pass them out beforehand so that instruction can be geared to the examples.

e. Improve the quality of written tests by using professional test development techniques. An effort is needed which will produce the following:

(1) Item pools
(2) Item statistics
(3) Alternate forms
(4) Test statistics
(5) Feedback to students

f. Improve the quality of Phase II EOC performance tests by sampling task segments at all stations.

g. Use videotapes of experienced mechanics performing various tasks to give an overview and to illustrate the pace and style of on-the-job repair.

h. Use computerized graphics to help trainees grasp difficult or abstract concepts, e.g., electrical and hydraulic systems, use of micrometers, timing of diesel engines, engine

cycles, etc.

i. Use a computerized scheduling program to reduce idle time of actual equipment trainers.

j. Add training on difficult maintenance conditions, e.g., "frozen" bolts, stripped threads, spilled fluids, accidents, fires, etc.

k. Develop training and/or job aids to help students operate training devices.

l. Obtain the benefits of both the team teaching method and in-place experts by assigning one or two "advisors" to each class instead of a team of 6-8 instructors.

8.0 APPENDIX

8.1 APPENDIX 1. Phase I Within-Course Test Data

Description. The first column within each Annex (A-G) shows the number of students who took the test. The number may decrease or increase across annexes because students are either dropped or recycled to an earlier block. The second column shows the number of students who failed (i.e., obtained less than 70% the first time they took the test). Overall failure rates (%) per annex are shown at the bottom of the table along with the minimum and maximum failure rates.

WITHIN-COURSE (ANNEX) TESTS

	A		B		C		D		E		F		G	
CLASS	N	FAIL	N	FAIL	N	FAIL	N	FAIL	N	FAIL	N	FAIL	N	FAIL
9	43	2	43	3	43	18	40	3	37	6	35	0	37	0
10	53	4	53	3	53	9	51	1	51	2	51	0	51	0
11	40	0	39	2	39	5	36	3	36	2	36	5	36	0
12	30	2	30	2	30	16	29	0	29	2	29	3	29	4
13	33	4	33	0	33	3	33	0	33	8	33	2	33	0
14	40	5	40	0	40	4	40	9	40	11	40	2	39	2
15	36	10	36	1	36	18	35	5	32	5	31	0	31	0
16	35	0	35	2	35	17	34	3	34	1	34	0	34	0
17	25	1	24	1	24	4	23	2	23	1	22	6	22	2
18	40	5	40	1	40	20	36	3	36	8	35	0	35	2
19	25	0	25	0	25	5	22	0	22	8	21	2	21	0
20	38	1	38	2	38	9	37	6	37	10		-		-
21	41	4	41	2	41	16		-		-		-		-
22	28	2	28	1	28	3		-		-		-		-
23	27	0	26	9	25	19		-		-		-		-
24	26	0	26	0		-		-		-		-		-
TOTALS	560	40	557	29	530	166	416	35	410	64	367	20	368	10
% FAIL		7.14		5.21		31.32		8.41		15.61		5.45		2.72
MIN-MAX		0-27.8		0-34.6		9-76.0		0-22.5		2.9-36.4		0-27.3		0-13.8

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